IAC-11.A7.1.2

THE NASA ASTROPHYSICS PROGRAM

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NASA's scientists are enjoying unprecedented access to astronomy data from space, both from missions launched and operated only by NASA, as well as missions led by other space agencies to which NASA contributed instruments or technology. This paper describes the NASA astrophysics program for the next decade, including NASA's response to the ASTRO2010 Decadal Survey.

I. INTRODUCTION

The NASA astrophysics Division forms part of the Science Mission Directorate. In the NASA 2010 Science Plan, the NASA Science Mission Directorate Astrophysics Division goals are to "Discover how the universe works, explore how the universe began and developed into its present form, and search for Earth-like planets." These lead to three broad questions:

- How do matter, energy, space, and time behave under the extraordinarily diverse conditions of the cosmos?
- How did the universe originate and evolve to produce the galaxies, stars, and planets we see today?
- What are the characteristics of planetary systems orbiting other stars, and do they harbor life?

The astrophysics program is organized to address these questions with three focused programs

- Physics of the Cosmos Program
- Cosmic Origins Program
- Exoplanet Exploration

In addition there are two cross-cutting programs, namely Explorer missions and Astrophysics Research.

II. CURRENT MISSIONS

The NASA astrophysics program can be characterized as being in the golden age of space astronomy. With thirteen missions currently returning data from space, scientists are enjoying unprecedented access to space astronomy data. Three of the original four Great Observatories, Hubble, Chandra and Spitzer are all still operating and productively return data in the X-ray, visible and infrared. NASA's collaboration with ESA on Herschel and Planck is providing scientists with data from the far infrared and promises to make another leap towards our understanding of the cosmic microwave background.

In addition to the James Webb Space Telescope, NASA is also preparing other missions such as the Nuclear Telescopic Array Telescope (NuSTAR) mission, the Gravity and Extreme Magnetism SMEX (GEMS) mission, a NASA contribution to the Japanese ASTRO-H mission, and a collaboration with ESA on the LISA Pathfinder mission, all for launch in this decade.

III. ASTRO2010 DECADAL SURVEY

The ASTRO 2010 Dedadal Survey [1], released in late 2010, is the latest in the series of Decadal Surveys to recommend science and mission priorities for the next decade. The ASTRO 2010 sets out three main science themes:

- Cosmic Dawn: Searching for the first stars, galaxies, and black holes to determine when and how the first galaxies formed and the earliest stars started to shine
- New Worlds: Seeking nearby, habitable planets to understand frequency of different types of planets and lay scientific and technical

groundwork to inform future strategies for detailed study of nearby Earth-like planets

- Physics of the Universe: Understanding Scientific Principles to determine properties of dark energy, reveal nature of mysterious dark matter, explore epoch of inflation and to test Einstein's general theory of relativity

The decadal survey recommended the Wide-Field Infrared Survey Telescope (WFIRST) as its top priority for large scale space programs for the coming decade. This telescope is envisioned as a 1.5 m class infrared observatory that will be used to provide data for dark energy and exoplanet research. The second priority in this class is to augment the Explorer program to allow for more frequent flight opportunities. The third and fourth recommendations include support for the LISA and IXO missions, two missions being considered in the ESA Cosmic Vision program.

In the medium class space programs, the Survey recommended support for a New Worlds technology development program, as well as an Inflation Probe technology program. The former to prepare for an eventual exoplanet characterization mission, while the latter would prepare for a next-decade cosmic microwave background mission.

IV. NASA'S RESPONSE TO DECADAL SURVEY

NASA's current structure of three programs already match very well with the three themes set out by the Decadal Survey. These programs have now all been established, with the PCOS and COR programs managed by the Goddard Space Flight Center in Greenbelt, Maryland, and the Exoplanet Exploration program managed by the Jet Propulsion Laboratory in Pasadena, California. Each program office is tasked with developing a competed technology portfolio to achieve the stated objectives of the Decadal Survey.

An Astrophysics Explorer Future Missions budget has been created with the aim of selecting four missions and four missions of opportunity for flight before the end of the decade, consistent with the recommendations of the Decadal Survey. In addition, a Science Definition Team for the WFIRST project has been selected to develop a reference design mission consistent with the science recommended by ASTRO 2010. NASA is also planning for concept and technology development for the other space missions, LISA and IXO. In addition, NASA is also exploring potential collaborations on ESA's propose Medium and Large Cosmic Vision missions.

V. ACKNOWLEDGMENT

This research was carried out at the Jet Propulsion Laboratory, California Institute of Technology, under a contract with the National Aeronautics and Space Administration.

VI. REFERENCES

[1] NRC Astronomy and Astrophysics Survey Committee, New Worlds, New Horizons in Astronomy and Astrophysics, The National Academies Press, Washington, DC, 2010.